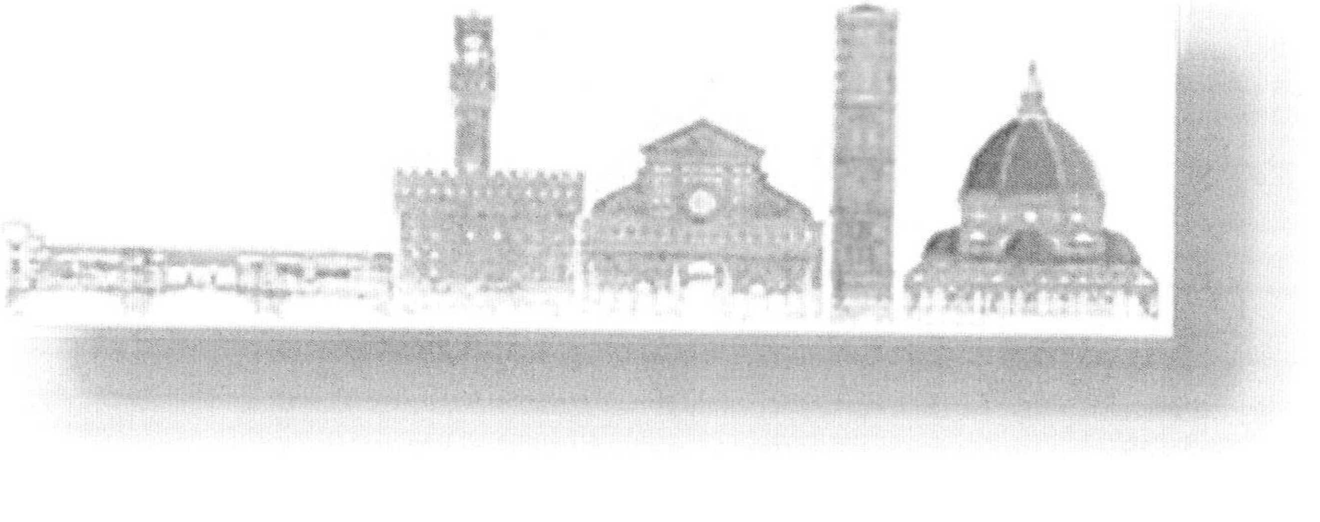
AISME ACCADEMIA ITALIANA DI SCIENZE MERCEOLOGICHE

UNIVERSITÀ DEGLI STUDI FIRENZE

PIN POLO UNIVERSITARIO CITTÀ DI PRATO — SERVIZI DIDATTICI E SCIENTIFICI PER L'UNIVERSITÀ DI FIRENZE

XXVIII CONGRESSO NAZIONALE DI SCIENZE MERCEOLOGICHE

Firenze 21-23 Febbraio 2018



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Ambiente, Innovazione e Sostenibilità sono alla base e il fulcro di una transizione sempre più evidente che delinea il passaggio da un'economia basata su un modello lineare ad una nuova economia fondata su un modello circolare, di creazione di valore che prevede sistemi, infrastrutture, modelli economici e tecnologie orientate verso lo sviluppo di organizzazioni sicure, etiche e sostenibili.

Il XXVIII Congresso di Merceologia, che si terrà a Firenze dal 21 al 23 Febbraio 2018, vuole essere un'occasione di confronto, studio e condivisione di percorsi di sviluppo su tematiche quali ambiente, sostenibilità, sicurezza, innovazione e qualità che stanno sempre più influenzando il sistema produttivo.

La Merceologia, declinata in chiave moderna, è una Scienza di indirizzo applicato che studia la natura, le proprietà, la qualità, la destinazione, la conservazione, le tecniche di imballaggio, la commerciabilità di qualsiasi tipo di merce (da *merce* e il suffisso, dal gr. λόγος, comune nei nomi di scienze; ted. *Warenkunde*). - È, con definizione generalissima, lo studio delle merci in quanto può interessare l'industria e il commercio. È una disciplina a sé nel gruppo delle commerciali ed economiche, ma in stretto rapporto con le chimiche, fisiche, naturali e tecnologiche. La figura del merceologo è quindi altamente interdisciplinare, dovrà essere fondamentalmente un chimico/tecnologo, con vasta cultura naturalistica e tecnologica e con adeguata cultura geografica, statistica ed economica o un economista/economista ambientale con ampia conoscenza dei processi produttivi, della sostenibilità della produzione e di tutte le problematiche legate all'impatto ambientale e tutela della salute umana.

Il vero concetto di merce dovrebbe scaturire da una sorgente più ampia che va dalle scienze naturalistiche nel più lato senso intese, a quelle geografiche, economiche, chimiche.

(Roberto Salvadori, 1925)

TOPICS OF AISME 2018

Energia, Ambiente & Sostenibilità

- Modelli di economia circolare e simbiosi industriale,
- Valorizzazione e tutela della biodiversità
- Life Cycle Thinking e relativi strumenti (LCA, LCC, S-LCA, LCSA),
- Efficientamento e diagnosi energetica,
- Responsabilità sociale di impresa ed etica di produzione,

Qualità, Innovazione e Tecnologia

- Qualità e Innovazione di prodotto e servizio, soddisfazione e tutela del consumatore,
- Sistemi di gestione ambientale, Sistemi di gestione integrata e certificazioni,
- Tecnologie avanzate per l'energia e l'industria, Trasferimento tecnologico: start-up e spin-off; R&S e tecnologie innovative,
- Innovazione e nuove tecnologie per l'informazione e la comunicazione IT e ICT,
- Nuovi modelli tecnologici: sharing economy, open innovation, added manufacturing

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Comunicazioni Orali

Poster

Energia, Ambiente & Sostenibilità

Heating energy consumption estimate for the School of Management and Economics (Unito) in view of a carbon footprint calculation

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ABSTRACT

The Commodity Science section of the Department of Management (University of Turin) has decided, in 2016, to partecipate in the Clim'Foot project, funded by the LIFE programme dedicated to the promotion of environmental protection initiatives. This project is aimed at the measurement of organizations carbon footprint, and the research team of the Department considered the application of the School of Management and Economics to this purpose to be an interesting opportunity. Following what recommended by the GHG Protocol, the research team has therefore begun to gather the necessary data in order to build the emissions inventory, among which there are those about the energy consumption of the organisation. In doing this the team has soon struggled with the lack of information about the heating consumption, mainly due to the presence of building sections created in different periods and to the existence of different authorities dedicated to its management. This problem, with the development of the project, turned out to be the most difficult to face in order to achieve a proper collection and interpretation of data. Starting from a bibliographical research, where energy measurements are mainly related to residential buildings rather than public ones [16], it has been proposed to proceed on the basis of the building volumetric measures and utilization time, presenting all the hypothesis developed to reach a reliable result in view of a carbon footprint calculation.

INTRODUCTION

The threat carried by climate change and the related agreements signed to tackle it are increasing the necessity to clarify which contributes are given by different activities to greenhouse gases emissions. The measurement of these gases is required to be carried out in a consistent and continuous manner. It is also a part of a wider inclination to measure and understand the environmental impact and resources consumption extent of each actor in the economic system, since their reduction brings benefits to both the environment and of general efficiency (Giama, Papadopoulos, 2016; Montoya-Torres et al., 2015; Tae-Woo et al., 2012; Ó Gallachóir et al., 2007). Greenhouse gases emissions measurement has so far been addressed to two main categories, products and organisations, through both individual initiatives and more extended projects, which involve and coordinate a greater number of different actors. This kind of assessment has been named carbon footprint, deriving partially the concept from the wider one of ecological footprint, which includes a bigger set of environmental impacts (Pandey et at., 2011). In particular, organisations carbon footprint, less known and used that the product one, is beginning to spread, thanks also to the gradual creation of measurement standards communal to all the interested actors, which allows a uniformed application of this tool (Raccomandazione della Commissione Europea, 2013). The Clim'Foot project, which the School of Management and Economics (SME) of the University of Turin take part in, requires the calculation of the organisation carbon footprint, having as final goal the increase of knowledge and diffusion about this tool among both private and public institutions. Therefore the School had to identify what are its activities that cause emissions, in order to build the inventory as required by the two main international standards regulating the matter, the GHG Protocolo and ISO 14064-1(Pandey et al., 2011; Vasquez et al., 2015). The process of carbon footprint quantification of an organisation is divided into three "scopes" that distinguish between direct and indirect emissions, depending if the source is internal or external to the organisation. The difference among the scopes lies also in the compulsory nature of the measurement of the first and second one, while the third scope is left optional, even if highly recommended due to the importance of the included activities. In the first scope are included all the emissions sources owned or controlled by the organisation, like boilers or vehicles, but in this specific case study the School does not possess any of them. The second scope includes indirect emissions caused by the generation of the purchased energy, such as electricity or heating, from third actors. The quantification of greenhouse gases emissions requires to multiply the energy consumption with emission factors (Pandey et al., 2011; GHG Protocol, 2004) that represent the quantity (in kg or tons) of carbon dioxide produced for every unit of energy consumed. It is then required to measure this consumption. This operation in the carbon footprint studies is usually accomplished using the information provided by meters or energy bills, especially for electricity and heating (Ó Gallachóir et al., 2007). In our case study this method has not created problems when used to detect the electricity consumption but it has not been possible to use it for the heating consumption because of the lack of data, due to some circumstances explained further. Having to obtain in other ways an esteem of the building energy consumption for heating, it has been observed how this result was reached in previous bibliographic experiences, for carbon footprint calculations or other purposes. From the literature analysis it has emerged that, being the air-conditioning consumption of buildings a significant percentage of the overall energy consumption, at a national and international level (Zhu et al., 2015; Krawczyk, 2016 e 2014; Beusker et al., 2012; Gram-Hanssen et al., 2011), the need to obtain the most precise measurement possible has already risen. This measurement should be able to give information on the most responsible aspects on the creation of the energy consumption, allowing thus to understand where it is more urgent and convenient to act for its reduction (Dascalaki et al., 2011; Stefanović et al., 2016). From the analyzed material these measurements focus mainly on residential buildings, while for the public ones the literature is less common (Krawczyk, 2014; Dascalaki et al., 2011; Ó Gallachóir et al., 2007). In both cases, literature studies can be distinguished in various categories, mainly on the basis of the objectives they are meant to reach though this calculation. Sometimes, in addition to the consumption quantification, they aim to explain which is the contribution given by several elements to the final result (e.g. the building dimension and shape, insulation quality, the existence and use of energy needing devices etc.), in order to understand what are the elements more responsible of the total consumption (Beusker et al., 2012; Ma et al., 2016; Audenaert et al., 2011; Zhu et al., 2015). Moreover often they concentrate on the difference between the share of consumption linked to the buildings structural characteristics and on the other side the share determined by users practices (Gram-Hannsen, 2011; Wang et al., 2015; Audenaert et al., 2011; Krawczyk, 2014). This requires the introduction of a probabilistic component, made necessary by the inherent unpredictability of human behaviour (Wang et al., 2015; Swan et al., 2009). In fact, unlike the more technical elements (e.g. the kind and quantity of technology existing in the building and its efficiency), that can be difficult to measure with good precision but do not include subjective aspects, individual choices regarding energy consumption can be influenced by the presence of some aspects (age, income, working situation, consumption habits etc.) but at the same time they can't be separated from a certain measure of uncertainty due to the arbitrariness of human choice. This uncertainty is reflected on the obtained results and, especially if the study observes a sample with the aim to examine some reference population, it affects the possibility to extend them on the entire set of cases. This is also influenced by the complexity of collecting good quality information regarding people's habits, since they can, for several reasons, give answers not perfectly corresponding to the truth or change their behaviour when aware to be observed. These aspects are valid especially about residential dwellings, while they are less common for public buildings where conducts are less dependent from discretional choices (Wang et al., 2015). Another category that can be identified among the literature references taken into consideration to learn about different methodologies of calculation, is the one where the authors aim to observe if there are discrepancies between energy consumption measured with models built including various elements (the same ones named previously, that contribute together to the creation of the total consumption), and the real consumption (Krawczyk, 2016; Audenaert et al., 2011; Corgnati et al., 2008). This second category includes also the works dedicated to analyze the issue of the potential energy savings that can be obtained with buildings refurbishment operations. The increased interest about this theme followed the consideration that expected economic and energy savings could be greater than the ones obtained after the modernization, thus increasing return on investments time and cost-effectiveness of interventions (Krawczyk, 2014; Audenaert et al., 2011). However, generally there is for all measurement experiences the building of a model that is meant to be possibly the most representative of reality, and so it has to take into account the factors influencing these consumes (e.g. in Corrado et al., 2007). The quantity and quality of the considered factors depends on the available resources, since data gathering can require to use technical tools, wide samples to observe and also time, that can be not so easily available. Nevertheless, models construction follows two main approaches: top-down or bottom-up, which differ accordingly to the nature of input data used and the aim of the works. In fact, while top-down models use mainly macroeconomic indicators and do not have the necessary level of detail to make evaluation upon a single building, the bottom-up ones starts from a single case characteristics (or a small number) and extend afterward the obtained results to a larger population (Swan et al., 2009; Wang et al, 2015; Stefanović et al., 2016). This method allows to reach a more detailed result, that can be used to understand how different elements contributes to the final result and how this consume can vary with the introduction of changes on the considered factors (e.g. refurbishment interventions and technological modernization) but it implies at the same time, a greater difficulty in the data gathering process and in the availability of both financial and technical means. Usually the aforementioned works used meters, environmental conditions sensors and other technological equipment, and all the parameters describing the buildings structure and the characteristics of their location were considered. Moreover in order to guarantee a greater reliability of results, observation and data collection are carried on for a long time, at least a couple of years, which requires a certain stability of working and environmental conditions and of the availability of means and documentation to complete the study (Krawczyk, 2016). As a consequence direct measurements are carried on only for a limited number of buildings of the observed sample and they are balanced with an additional and wider data collection through surveys, as for example in the work of Wang et al. (2015) and in Beusker et al., (2012). In the vast majority of the observed cases the energy consumption quantification realized with this kind of models and with this degree of detail was not directed to the building of a carbon footprint. When previous experience of carbon footprint calculation in a university organisation have been taken into account, two different classes of experience have been identified, the gathering of data already registered and processed from services operators or power companies (Vásquez et al., 2015; Frączek et al., 2016; Filippín, 2000; Alvarez et al.,2014; Moerschbaechter et al., 2010) and on the other side information collection done without involving other actors. These last investigations can have different degrees of detail, there can be experiences as in Escobedo et al. (2014), where three different audits have been realized taking into consideration every kind of energy end-use equipment consumption and daily time of use, or they can be limited to the observation of values resulting from meters situated in the internal environments or in the central control unity as in Ozawa-Meida et al. (2011). Another example is given in Abdelalim et al. (2015), where the first goal of the study is to measure energy consumption and this is done in a rather precise way, extending in a second moment the possibility to use the results to obtain the correspondent greenhouse gases emissions. In the SME case study the documentation needed to obtain energy consumption values straight away is not available, and the same goes for the equipment that could provide them. The participation to the Clim'Foot project has as a purpose not only to calculate a certain organisation climatic impact dimension, but also to identify what are the consumes upon which it is more required an action. This means that the definition of a base level is needed, in order to correlate the further improvements that can derive from the introduction of energy efficiency measures, and then it has been necessary to obtain at least an esteem of consumes despite the consistent gaps found. In addition it has been possible to understand what the present situation is regarding the management of heating energy consumption, which is an essential element needed for the necessary correction in order to obtain a better quality and more solid information in the future. The aim of this study is then to show how, in a moment when the necessary data were lacking, it has finally been possible to build a consumption esteem considering the several elements that constitutes the present situation.

MATERIALS AND METHODS

The Commodity Science section of the Department of Management (University of Turin) has decided, in 2016, to take part in the Clim'Foot project, which consists in measurements of the carbon footprint of some organisations that, in various European countries, have been willing to participate. In this specific case the School of Management and Economics, whose main building in the city of Turin hosts the Department of Management and the Department of Social, Economic and Statistical Sciences, has been nominated. The project includes a function of coordination and support to the participating organisations provided by national agencies (in Italy ENEA) and the provisioning of a proper software for this kind of calculation. Moreover one of the project's purposes is the building of national databases of emissions factors and guidelines created thanks to this experience, which will be useful to help this kind of initiatives in the future. In the data collection process, the main obstacle met concerns the measurement of the building heating energy consumption, and how its system is structured, being these the most relevant information usually gathered in energy consumption studies (Desideri et al., 2002).

SME main building

The problem derives from the original function of the building. It was in fact a retirement home for poor elderly people, built at the end of the 19th century and now occupied only in part by the SME. The building, entirely brick made with a concrete inner structure, is constituted by a two floors section developed alongside Corso Unione Sovietica, where the main entrance is situated, and of more three floors wings perpendicular to it, of which only two are owned by the University. The remaining three are managed by separated organisations with different functions, in particular part of the building is still dedicated to hospital handling. The whole edifice is one of the biggest among the historic ones in the city, and it was realized in an efficient way for its original purpose, but it is not suitable now for the new necessity of educational spaces arose with the moving of the university offices, which often required big classrooms and a better accessibility to the building. The problem could hardly be solved with a complete change of the building original shape, given its particular characteristics and the architectonic value, therefore the construction of a new structure was preferred, separated from the main one and located in the yard between the two wings occupied by the University. The historic building nevertheless has not been exempted from modifications. The northern university wing has seen internal renovations, mainly to allow the presence of classrooms, and the creation of an external additional body that extend its length. The more recent structure includes big and medium dimension classrooms (424, 270 and 120 seats) and some smaller ones. There are in addition computer labs and other areas dedicated to reception services or other functions needed in this kind of institutions (toilets, bar, study rooms etc.). In the historic building wings there are the department employees offices, mainly in the southern wing and in the superior floors of the other one, medium size classrooms, a bar, the students administrative office and other general use spaces. In addition the building has a basement, partially occupied by the library. The building includes then, as usually happens with educational structures, spaces with various dimensions and with different functions depending on the activities proposed, with different operating times and as a consequence different consumes. Moreover, having maintained the original characteristics of the structure, the rooms especially in their height have notable sizes (the vault reach 6,5 m) and then it is necessary to take into account volumes rather than surfaces when trying to measure energy consumption and confronting them with other cases, situation that has already been experienced previously in case of a conversion of historic buildings to current purposes (Desideri et al., 2002). The present situation then sees the existence of various parts of the building realized in different periods and as a consequence with dissimilarities in their structural and systemic characteristics.

The heating system

The heating in the building is provided through the city district heating. Hot water that allows the heating of internal environments is transferred through a main pipe that branch off around the different wings. At the dividing points there are sub-stations which allow to control the water supply to the wings independently from one another. These substations however do not include consumption meters, then when consumption has to be measured the building is considered on the whole without a distinction between the various organisations occupying it. The University area is interested by three sub-stations, two of them are controlled by a company linked to the University, the last one by Iren, the company who manages the energy supply district network. As a consequence the way heating is supplied change among the building sections managed by the different subjects, and so it has to be taken into account every section with its specific conditions without the possibility to consider the university area in its whole. This area is conventionally divided in six lots, three of them are linked to the sub-stations run by the University, the others are linked to the remaining sub-station. The differences caused by the separated management of the sub-stations are for example given by different running times of the heating system, both among different lots and in different periods of the year, and are reflected also in the internal heating equipment. In fact, while in the wings where the system is run by Iren the original radiators have been maintained, in the others they have been replaced with fan coil units.
The University pays a bill of which amount is estimated and later subject to a periodic balance, deposited with a frequency of more years. It is not possible then to know the total consumption using as a reference source the energy bill. To sum up the situation, there are no meters specific for the University area heating energy consumption nor energy bills with reliable indications and the building at the time being has no energy performance certificate, so it is not possible to obtain useful data. Given this complex and inefficient situation, the University has decided to independently install some meters used to measure the consumptions in the building wings it owns, in order to obtain the needed information to evaluate them with precision. This purpose however has been put into effect only for two of the three wings, where meters have been installed in the sub-stations in January 2016, for the first wing which includes lots 7 and 7A, and in January 2017 for the other one, which includes lot 6A. The only complete data now available is then the one regarding the consumption of a wing in an only year, 2016, having to wait until the end of 2017 for an annual reading of the other meter to be obtained.

The consumption measurement

The adopted solution has then required the use of the value resulted from the meter for the year 2016, which has been used to calculate the consumption for unit of volume. The choice of considering volume instead of

the surface has been made in order to take into account internal environments dimensions, that, as said before, in height exceed standard measures. Once obtained the consumption per unit, this has been used to calculate the total University area consumption, considering from time to time the different lots volumes.
This method then start from a value and obtains in a proportional way the values of a bigger area. The procedure has already been applied in previous literature cases, for this same purpose or to make comparisons with different buildings in other climatic regions or with different characteristics such as activities time (Dascalaki et al., 2011; Escobedo et al., 2014; Corgnati et al., 2008; Beusker et al., 2012). The choice to adopt this method has been imposed by the lack of possible short term alternatives. There was in fact neither the possibility to obtain quickly the information from the companies who run the service, nor the material and financial availability to use technical equipment specifically set up to detect energy consumption. Moreover the use of this sort of tools requires an observation activity possibly for a long period, which in most of the literature cases analyzed exceeded one year. In the present situation then it has been preferred a method that even if it gives less accurate results, it allows to reach an acceptable approximation of this particular energy consumption. Even in other situations where lacks of information have been experienced the problem has been solved using medium data, adapted taking into account the specific conditions of the observed case study (Chen et al., 2011; Escobedo et al., 2014). Also, it has to be taken into consideration is that the aim of this study is not to understand what is the precise needs of energy to heat the structure, but to measure its real consumption, that could also exceed the amount strictly required given the building characteristics and the activities carried out. An example is given by the present situation of the SME, as has already been said the building hosting it is rather old and consequently to allow the use of its environments some refurbishment and security interventions have been necessary. These however have not been concluded, and the superior floors in one of the wings are still closed. However they are heated, and this results in an increase of consumption with no connection to a real exploitation of the space, that distances real consumption from the strictly needed one. Given that the final aim is to link this consumptions to the correspondent quote of greenhouse gases emissions in order to built a climatic footprint of the SME, the creation of a model representing the theoretical energy needs, even if a thorough one, does not give the result looked for to the purpose of this project.

RESULTS AND DISCUSSION

As explained in the previous paragraph, the method adopted uses the only consumption value available as starting point to obtain the whole total. Some other aspects have to be considered in order to limit even more the results reliability. Lots 7, 7A and 6A, correspondent respectively to one of the historic structure wings, its more recent extension and the new wing, have settings and working hours different from lots 4, 5, 6, correspondent to the second historic wing (lot 5) and to the branches (lots 4 and 6) connecting it to the rest of the building.

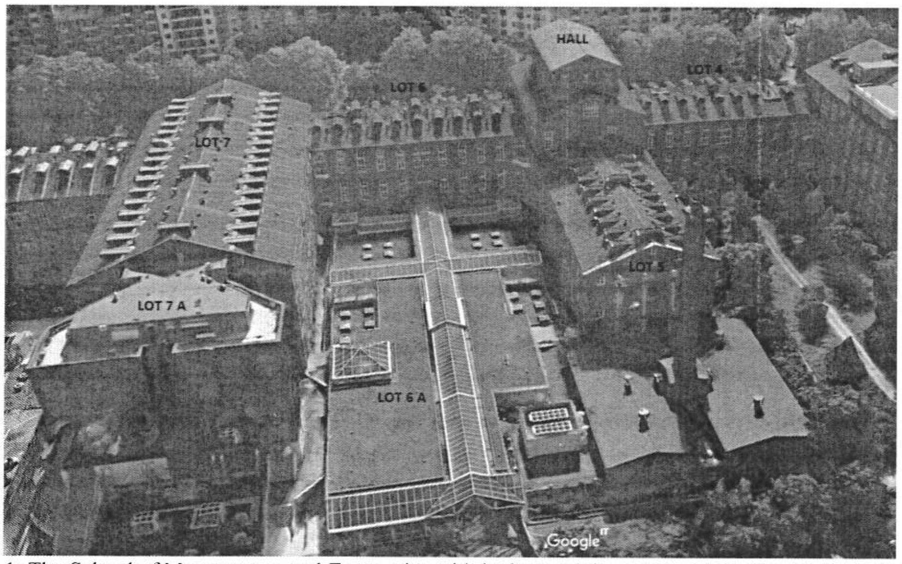

Fig 1: The School of Management and Economics with its lots and the entrance hall (Google Earth 2017)

The winter heating period goes conventionally from the 15 of October to the 15 of April. Within this period for what concerns lots 7, 7A and 6A two sub-periods can be identified, the first including December, January and February and another including October, November, March and April. In the first sub-period the heating service runs every day for 24 hours, while in the second one it runs for twelve hours only in the five working days to which are added seven hours on Saturday. As shown in the table, it has therefore been obtained the total amount of hours of running heating in the winter period for this three lots.

Lots 7; 7A; 6A	Period	Hours	Days	Total days	Total hours
	December, January, February	24	7	91	2184
	October, November, March, April	12	5	69	828
	Saturday	7	13		91
TOTAL					3103

Table 1: total amount of hours for lots 7, 7A, 6A

In the same period the remaining lots did not have these differences in the working hours, so the functioning has been kept unchanged for the 26 weeks, where heating is provided every day for 24 hours. However a first approximation has been introduced here because of the existing difference between the working conditions during daytime and nighttime. In fact, while during the day, for 18 hours (from 4 a.m. to 22) the heating is set to provide an internal temperature of 20 degrees, during the remaining hours the temperature is lowered to 17 degrees. This difference should have been considered because it reflects on consumptions but, after an evaluation it has been decided to consider instead a full working regime (the daily one) for all the 24 hours. The reason on which this decision is based is given by some considerations on previous experiences in other university buildings, it has in fact been found that where they were not connected to district heating, and then heating was provided by boilers, to distinguish between a daily and nightly consumptions did not bring the desired results. This because the starting of the boilers in the morning and the work required to obtain the daily temperature compensated the reduced consumption obtained thanks to a lower temperature during the night, without having appreciable gainings. The SME is served by district heating so it does not own boilers, but it has been believed that this principle could be considered true anyway because of the greater temperature required to heat the system internal water in the morning. Therefore, ignoring this difference on temperature, it has been considered a uniform functioning for 24 hours every day of the week, obtaining the total amount of hours for lots 4, 5 and 6.

Lots	Period	Hours	Days	Total hours
4; 5; 6	26 weeks	24	7	4368

Table 2: Total amount of hours for lots 4, 5, 6

It has moreover to be said that the distinction between the full and reduced working regime does not only concern the nightly heating in these three lots but also the entire summer period when the district heating water is provided to the entire building to guarantee the domestic hot water and the running of fan coils post-heating batteries. However these services are provided to the building but not to the university areas, because post-heating batteries are not used, in order to save energy, and domestic hot water is provided using separated boilers, so the only consumption to be considered is the winter heating one. The meter observed includes lots 7 and 7A consumption, giving a yearly value for 2016 of 627.600 kWh. The two lots volume is of 60.932 m^3, from which we can derive that the consumption for unit of volume is 10,30 kWh/m^3. Taking into account the total amount of hours we obtained the hourly consumption, used as base unity to obtain the other lots consumption, taking into account their volumes and working times, as shown in the following table. As can be seen the consumption for unit of volume and hour is the same for all the lots, and has then be multiplied for the respective volume and hours of every lot.

Lots	Volume (mc)	Total consumption (kWh)	Consumption per mc (kWh/mc)	Hours	Consumption per mc and hour
7-7A	60.931,50	627.600,00	10,30	3.103	0,0033
6A	54.667,80	563.083,29		3.103	0,0033
4	14.630,00	212.122,26		4.368	0,0033
5	21.210,00	307.526,53		4.368	0,0033
6	17.870,00	259.099,44		4.368	0,0033
entrance hall	6.000,00	86.994,78		4.368	0,0033

Table 3: Total heating consumption of every lot

From the sum of consumption of all the lots it has been obtained the total amount for the university area, of 2.056.426,29 kWh. One last approximation derived from this method is that the university area is formed by a historic unit to which other parts have been added more recently. The difference in the building periods reflects on the structure characteristics and then on energy consumptions. To use one single data as it has been done here does not permit to take into account this aspect, because it does not consider differences among lots. Actually the meter data concern two different lots, one located in the historic building and the other in one of the more recent parts, so it can be considered an average between structural characteristics of different areas. Nevertheless it is an approximation of the real situation, which hopefully will be solved when the second meter will provide the consumption value for lot 6A, the most modern one and so where probably consumption is more different from the other parts of the building.

CONCLUSIONS

Bibliographic research did not provide strong basis about the possibility to obtain useful data to estimate the heating energy consumption of a building. This work had as aim then to show the complexity linked to the measurement of a type of energy consumption, carried out during the implementation a project requiring the quantification of the School of Management and Economics of the University of Turin carbon footprint. The need to obtain from the little information available an estimate of total heating energy consumption has required to use a method based on a single data possessed, provided by a meter that measures energy consumption of only a part of the building. The problems met and the necessity to accept the existence of a certain degree of approximation on the result achieved have helped to made clear the need to have a simpler service management, able to guarantee an increased consumption efficiency. This is a fundamental step to improve the building energy performance, especially if, as in the present case, it concerns historic buildings where realizing significant modifications in order to obtain energy savings is difficult because this could clash with the maintenance of the original architectonic aspect (Zagorskas et al., 2013).

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